Lautenbach (L. J.) Compliments of the Author

[REPRINT FROM MEDICAL AND SURGICAL REPORTER OF MARCH 7 AND 14, 1885.]

THE INCANDESCENT ELECTRIC LIGHT

FOR THE

Examination of the Throat, Nose, Eye, and Ear;

AN ELECTRIC OPHTHALMOSCOPE.

By LOUIS J. LAUTENBACH, M. D.,

OF PHILADELPHIA.

My experience with various kinds of lights has been derived from the examination of the throat, nose, eye, and ear; as applied to other portions of the human body, I will not pretend to speak. In the present paper, I desire to call attention to the advantages of the incandescent electric lamp in the exploration of the parts before mentioned, but particularly in examination of the eye-ground.

Since the employment of the reflecting mirror, the illumination of the various parts of the human body, by means of artificial light, has been continually under discussion. As sources of light, the wax-candle, the oil-lamp, the gas-burner, the lime and electric light, have each been used. These lights have been modified in numerous ways to obtain the maximum brilliancy, the least yellowness, and to concentrate the light. The first was obtained by consuming a larger amount of material by means of an increase in the surface of the burners, and by increasing the thoroughness of combustion. As a result, we have the Argand burner, the Siemens' lamp, the student lamp, and other round and broad burners. To overcome the yellowness of the rays, slips of blue-glass have been interposed between the source of light and the reflecting mirror. To concentrate the light, convex lenses have been employed, being placed so as to intercept the light falling on the reflecting mirror; as illustrations, we have the Mackenzie concentrator and the Tobold lamp.

The lamps devised, in which it has been sought to incorporate one or more of these advantages, have been quite numerous; one is particularly struck by the number which have been designed for ear examinations. The Argand burner, the student lamp, the Tobold lamp, with, perhaps, one or two others, are about all which have been saved from the general wreck; of course, the lime and electric lamps are not here considered, both being but in their infancy; the Siemens' light is also passed by, because, so far as I know, the manufacturers have no intention of making them sufficiently small to allow of their introduction into private houses.

It is well known that there are two kinds of electric light—the arc light and the incandescent light. The arc light is occasioned by the combustion usually of carbon at the positive pole and the carrying to the negative pole of unconsumed, but intensely-heated particles of carbon. The light is of great intensity, and is, in consequence, of a violet-white color; it is, however, unsteady, having a strong propensity to vary in brilliancy, even sometimes to the point of absolute extinction. The most important objection, however, is the intense heat occasioned; it is mainly because of this fact that it is unsuitable for medical examinations; the intensity and unsteadiness being, however, also factors in precluding its use.

Believing that it will be impossible, for the present at least, to use the arc-light successfully for the examinations of special organs, I will not bestow more attention upon it, and will, therefore, use the terms electric light and incandescent light synonymously.

In the incandescent lamp there is no combustion, the carbon filament, within as absolute a vacuum as is possible at the present day, becomes incandescent by reason of the resistance it offers to the passage of a current of electricity.

HISTORY OF THE INCANDESCENT LIGHT AS APPLIED TO THE SPECIAL ORGANS UNDER DISCUSSION.

So far as I have been able to discover, Bruck,* a dentist of Breslau, was the first to construct and use an incandescent lamp for the examination of human structures. His instrument was known as the diaphanoscope. It consisted of a coil of platinum wire placed in a glass tube surrounded by a column of water. This was followed by Gustave Trouvé's † polyscope, which was exhibited at Baden-Baden in 1879. This consisted of an unprotected platinum wire placed in front of a concave mirror. The objection to its use was its heat, which sometimes was sufficiently great to fuse the platinum. This was followed by Dr. Nitze's ‡ instruments for the examination of the urethra, larynx, etc. Shortly after this, Dr. A. Wellington Adams ‖ published an account of an electric laryngoscope, which consisted of the ordinary laryngeal mirror, on the handle of which was a concave mirror, in front of which was placed a spiral tube containing a platinum wire in a carbonic acid vacuum. This wire was rendered incandescent by means of a Ruhmkorff coil. He used this instrument for the larynx and posterior nares. He promised that the description of an electric otoscope, which he proposed exhibiting before the Colorado State Medical Society, May 19, 1880, would appear in the September number of *The Colorado State Medical Journal* and *Rocky Mountain Medical Review*, but I have not been able to find any reference to this article.

About this time, Josef Leiter § constructed instruments for the examination of the various organs. He made use of the light derived from an incandescent platinum wire; this was usually placed behind a window or ledge, to prevent contact with the structures under examination. The instrument was cooled by the circulation of water. It, however, was necessarily bulky, and was either too warm, or else the light was so dim that nothing could be seen.

A year or two later, Carl Seiler ¶ began to use the reflected rays of the Edison incandescent light, which he must have considered of value, as he writes: "I have no doubt that in the near future, when electric lighting will have been adopted universally, as gas is now, electric-lamps for the laryngoscope will supplant all other sources of light, with the exception of sunlight."

On the 16th of April, 1883, the instrument of Dr. Paul Helot and G. Trouvé was presented to the French Academy.* The description was published shortly thereafter.† The instrument was known as the frontal electric photophore. It consisted of a metal cylinder attached to the ordinary head-band. Within the cylinder is a small incandescent lamp; back of the lamp is a concave reflector; anterior to it is a strong convex lens to concentrate the light. This instrument has been successfully employed by Dr. E. C. Baber ‡ for the examination of the throat, nose, and ear. About this time, Simanovoski ‖ published a description of an electric laryngoscope, but as yet I have not been able to obtain a description of the instrument.

Dr. Carl Seiler § exhibited his electric laryngoscope before the Pennsylvania State Medical Society, May 16, 1884. It consists of the ordinary concave head mirror, with a bar attached to its lower edge. The incandescent lamp is placed on this bar; between the lamp and the mirror is placed a strong convex lens, while between the lamp and the patient there is a mica shield. Dr. S. S. Cohen ¶ advises the use of the incandescent light in connection with the Mackenzie condenser. Dr. Laurence Turnbull** exhibited the laryngoscope of Dr. Starr†† before the Philadelphia County Medical Society, October 22, 1884. It consists of an incandescent lamp, placed in a hollow cylinder of rubber, to the end of which cylinder the laryngeal mirror is attached. It is the object of this instrument to illuminate the parts under examination by means of direct rays of light. A very important measure incorporated in this instrument is a method of regulating the current, and thus regulating the illumination.

* Chambers' Jour., vol. 58, 1881, p. 314.

† Popular Science Monthly, vol. xvii., 1880, p. 110; also Annals of Anatomy and Surgery, vol. vii., 1883, p. 128.

‡ Annals of Anatomy and Surgery, vol. vii., p. 127.

‖ Archives of Laryngology, 1880, vol. i., p. 368; also, New York Medical Gazette, 1880, p. 324.

§ Beschreibung einer instrumente und apparate zur direkten Beleuchtung menschlicher Körperhöhlen durch elektrisches Glühlicht, Wien 1880; also, Annals of Anatomy and Surgery, vol. vii., 1883, p. 129.

¶ Diseases of the Throat and Nose, 2d edition, Philadelphia, 1883, p. 22.

* Proceedings of the French Academy, Paris, 1883, vol. i., p. 1164.

† La Nature, Paris, 1883, vol. i., p. 416.

‡ British Medical Journal, 1883, vol, ii., p. 916.

‖ Ejened. Klin. Gaz., St. Petersburg, vol. iii., 1883, p. 473.

§ Transactions Medical Society of Pennsylvania, vol. xvi., 1884, p. 349.

¶ Medical News, Philadelphia, vol. xlv., 1884, p. 81.

** Proceedings Philadelphia County Medical Society, vol. vii., p. 56; also, Polyclinic, Philadelphia, vol. ii., 1884, p. 77.

†† Electrical Review, London, vol. xv., 1884, p. 424; also, Scientific American, October, 1884.

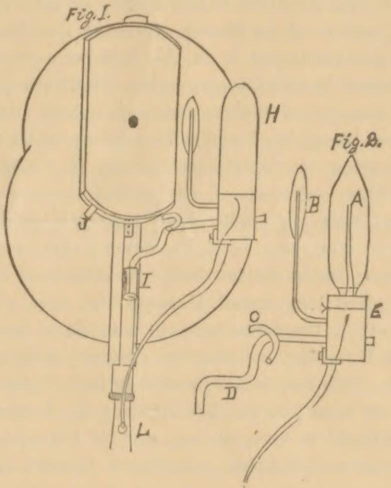
The objection to all instruments employing an incandescent platinum wire is that to obtain sufficient light the heat generated is so great as to fuse the wire. In Bruck's instrument its size debarred its employment except for oral examination: Nitze's instruments were too large for practical use; in Leiter's instruments, the two essential water-pipes made them too bulky; in Adams' laryngoscope the light was apparently too poor. Trouvé's frontal photophore is a very servicable instrument. Dr. Seiler's instrument is practically but the photophore placed in front of the head mirror; its disadvantage is its weight. The disadvantages of the Starr instrument are the slight heat occasioned and the fact that the eye is not thoroughly protected from the light.

Up to the present time, the incandescent light has apparently not been employed for the examination of the eye. Dr. Seiler,* speaking of his electric laryngoscope, writes that "it may be used for the examination of the eye," but does does not appear to have so employed it. I have been using the electric light for this purpose for a period of more than five months.

AN ELECTRIC OPHTHALMOSCOPE.

As will be indicated later on, I have employed the incandescent lamp in the ordinary situation of the gas stand, also within a Tobold condenser, as well as attached directly to the ophthalmoscope, employing the light with plane and concave mirrors, the latter of from three to fifteen inches focal distance. The method which has been of the most service where small lights only could be employed, was that adopted in the instrument here figured. Fig. 1 is ¾ natural size, Fig. 2 being the exact size of the lamp.

It consists of an ordinary Hunter's Loring swinging mirror ophthalmoscope, to which is soldered the slot I, fitting into this slot is the arm D, which carries upon it a hard rubber cylinder, E, which can be slid down closer to the mirror if desirable; this rubber cylinder carries upon its upper extremity the incandescent lamp A, over which is fitted the asbestos (non-conductor of heat) cap H, between which and the posterior surface of the lamp is the reflector. Fitting into the rubber base, E, is a wire carrying the biconvex lens B of ¾ inch focus. The lens can be approached to the light at will. It should, however, be placed at about half an inch from the filament. On the bar D is a cross-bar C, the ends of which strike against the projections of the swinging mirror J. This bar is of such length on either side as to place the lamp at an angle of 60°, with the general plane of the mirror: by this device, the swinging mirror is placed in position for one or the other eye, by adjusting the lamp for the same eye. The wires are carried from the hard-rubber piece either down to an opening



L, entering a hollow fixed handle, or to a ring which slides easily about the lower end of the handle: this latter device allows of the ready detachment of the handle. Two asbestos caps are employed: in one the light makes its exit through a small round opening; in the other, which is only used occasionally, the opening is a vertical slit. The convex lens concentrates the light and renders it almost parallel. I have employed the plane reflecting surface in connection with this lamp, but have not found it as satisfactory. A concave reflector with a focal distance of three inches, I used without benefit. If the amount of light obtained in the eye is more than the observer desires, it is only necessary to revolve the lens B out of the field of light.

* * * * * * * *

This light will prove of advantage in the examination of the dark complected; whenever there is a small pupil; of myopics—in all of these cases giving us better illumination than we can obtain by other means. It will be of service in atrophic nerve cases, but its advantages are particularly marked in slight retinal inflammations, and for the study of the retinal circulation. Because of its intensity, it will allow us to make more thorough ophthalmoscopic examinations in cases of corneal, lens and vitreous opacities.

*Transactions Pennsylvania State Medical Society, vol. xvi., 1884, p. 351.

It may not be uninteresting, nor is it without the scope of this paper, to consider the various forms of incandescent lamps, and the means of generating the electricity suitable thereto. A very good opportunity of observing the different varieties of lamps was afforded at our Electrical Exhibition a few months ago. Of the numerous incandescent lamps exhibited, it will be necessary to call attention to but a few. In the Bodein lamp, exhibited by Messrs. Queen & Co., the incandescent filament is in the form of a straight bar placed at right angles to the platinum poles. The intensity of current required is low. In the Weston lamp, the filament is a series of undulatory curves ; in the Bernstein lamp it consists of a hollow cylinder of carbonized woven silk, shaped like a U, with long arms, requiring, to produce whiteness of light, a very high tension current ; in the Edison lamp, it consists of a fine carbonized long-armed U, requiring, also, a high tension ; in the Swan lamp, it consists of an elongated U, with a round loop situated within the curve. This loop is not present in their lights less than 40 volts ; in the Baudet lamp the filament is quite broad in cross section, and is U-shaped ; it requires considerable quantity of current of low intensity.

In my work, I have used the Swan and Edison lights, as well as the small lamps of Dr. Starr (obtained at S. S. White's dental establishment). The Swan light used by me was a nine-volt lamp of slightly more than two-candle power ; the filament a slight curve 6 mm. in length. The Edison light, which was placed at my disposal through the kindness of a friend, was a 16 c. p. 95-volt lamp, the arms of the U-shaped filament being 7 cm. in length, and separated 2 cm. from one another. The Starr lamps were both of them of about $1\frac{1}{2}$ c.p., the one being a 3.8-volt lamp, the other slightly less ; the filaments were slightly curved, one 4 mm., the other 2.5 mm. in length. The employment of the electric-light without the use of any lenses, will often prove satisfactory, the objection to its use in this way being that with the smaller lamps employed the illumination is poor, and the image of the incandescent filament is quite small. A very important question which must be here considered is the production of the electricity to work the lamp. How are you going to obtain it? from a chemical battery, a dynamo, or from either one in connection with a storage battery? Hoping that our electric-light companies might be able to furnish it, I inquired at the offices of the Maxim and of the Brush Cos. At the Maxim's office I found them willing to supply the entire plant, consisting of the lamps, with a dynamo machine to supply them ; it would, with the necessary engine, cost several hundred dollars. They were not able to supply lights from their office, but hoped that they would be able to do so some time in the future At the office of the Brush Company, who own the American rights of the Swan light, I found that they would put in the lights with the dynamo, but that they were engaged in the perfection of storage batteries, which were to be supplied from their arc-light wires. They thought the problem of supplying the incandescent light was in a fair way of solution; that progress was being made from day to day. This company is at the present time supplying the basement of John Wanamaker's Thirteenth Street store with some seventy 8 c.p. Swan lamps by means of the current from a secondary battery, charged from their arc wires. The examination of the lamp on December 6th, 1884, showed it to be a Swan-loop lamp, the straight arms of the U being 2.5 cm. long and 2 cm. from one another, the loop being, therefore, 2 cm. in diameter. The light was of a decidedly yellow color, the intensity of the current being too low to attain the desired whiteness, the light, however, being steady and quiet ; the light given forth December 10th was a nearer approach to whiteness.

Not desiring to purchase a plant, I endeavored to employ the chemical battery, and in a measure succeeded. The Grenet battery, because of its high intensity, appeared desirable, but unfortunately the elements soon polarize and its efficiency rapidly diminishes. The battery requires considerable attention ; the zincs must be removed from the liquid after using, they must be kept clean and freshly amalgamated, the liquid must be frequently renewed.

The Bunsen battery has also been used for electric lights. It is a battery which in its practical workings is of comparatively low intensity, and is very dirty, too much so to have in one's office. At the Electrical Exhibition it was used to furnish the current for three small microscope lamps of about 1 volt each. Two gallon Bunsen cells were employed, the liquid being renewed but once during the course of the Exhibition, the lamps being used one or more hours every day for some 35 days. The light, because of the low intensity of the battery, was decidedly yellow.

The Leclanché battery is an open circuit battery, also of low intensity. Its employment is attended with indifferent success.

The Fuller battery, as modified by Dr. Starr, is

also an open circuit battery, but unlike the Bunsen and Leclanché, is of high intensity, each cell having an electro-motive force of almost 2 volts. This battery has been used for intervals throughout the day for more than three months, without requiring renewal of the plates nor recharging.

The bisulphate of mercury battery has been employed, but runs down too rapidly.

For the 2½ c. p. 9 volt Swan lamp, I employed 6 to 12 half-pint Grenet cells, coupled for intensity, giving me, therefore, when the battery was fresh and in perfect order, an intensity of about 20 volts. I found that this battery would answer fairly well, using it from 30 to 45 minutes per day, actual working time, for about a week. If after this it was used without renewal of the fluid, it could not be depended upon, the lamp perhaps burning well for a moment, and then becoming dull red.

The 2½ c. p. Swan, when supplied by three half-gallon Fuller cells, gave a fairly good light, apparently steady after the battery had been used for more than three months. Had I been able to employ four of these cells, I do not doubt but that the whiteness of the light would have approached, and perhaps equaled that obtained from twelve fresh half-pint Grenets.

For the 1½ c. p. 3.8 volt Starr lamp, I made use of four Grenet cells, half-pint each, and found the light thus obtained of a beautiful whiteness. When, however, the battery had been employed for about thirty minutes daily, after six or seven days the light became yellow and not to be relied upon, the battery requiring fresh fluid.

The 16 c. p. 95 volt Edison light used by me, was supplied from a dynamo machine, and gave a most beautiful light.

Objections which have been urged against the employment of the electric light in examinations of the human organs are: first, the great heat; secondly, the intensity of the light; third, the sharp shadows occasioned; fourth, the presence of the sharp image of the incandescent filament wherever the light is thrown; fifth, its unreliability; sixth, its expense.

Taking up these objections seriatim, we will discuss first the question of the excess of heat. The incandescent electric light is peculiarly free from appreciable heat, provided the lamp has been well made, the vacuum being good. This is because there is no combustion. There is nought but an incandescent filament of carbon suspended in a vacuum. There is in fact so little heat created by the well-made lamp that it was only with difficulty that the rhinoscopic mirror could be heated sufficiently by the 16 c. p. 95 volt Edison, to prevent the deposition of moisture.

The second objection mentioned was the intensity or the brilliancy of the light. As yet, this has caused me no inconvenience. On one occasion I used the 16 c. p. 95 v. Edison steadily for an hour, giving forth a most brilliant bluish-white light, using it for the examination of a friend's eyes at least half that time, with a peculiar absence either of momentary blindness, or the least irritability occurring either in my friend's or my own eyes. This examination was made between 10 and 11 p. m., after a full day's work, and was followed the next morning by a feeling of utmost comfort in both cases. Since this was written, I at night examined the left eye of a friend with the 1½ c. p. Starr light continuously for more than an hour, not only with no inconvenience to either of us, but with a feeling of the utmost ease, comfort and rest being present the following morning. However, in examinations with an intense white light, one must be careful not to gaze directly at the filament before making the examination, as in that case it will be difficult, because of the inferior intensity of the reflected light, to study structures carefully. This is easily prevented by interposing a shade between the light and your own eye, being careful not to obstruct the rays falling on the reflecting mirror.

The sharp shadows, instead of being a disadvantage, are in many cases very serviceable. In order to understand the reason of this, we must consider the nature of the light we are dealing with. In the electric lamp, we can get the light from a full red to extreme whiteness, the color depending mainly on the intensity of the current. By using a current of sufficient tension to produce a brilliant white light, we obtain not only the light from the incandescent filament, but we also have a less intense violet-white light occupying the entire globe of the lamp. If we look at an incandescent light, this luminous sphere may be so intense as to prevent us from seeing the filament. When the electric light is reflected upon the membrana tympani, or upon the retina, or upon the structures of the posterior nares, we notice the image of the filament very distinctly; this is surrounded by the illumination derived from the vacuum (if it may be so called) surrounding the filament. This general illumination may be used as readily as gas-light; the special illumination being used for the throwing of shadows, thus studying elevations and depressions, and for the more particular study of the structures. By throwing the bright image at

various angles, we can not only overcome the shadow at any particular portion, but we can also study the more carefully any variations from the general curvature of the parts. By means of the shadow the curvature of the turbinated bones can be studied much more satisfactorily. The shadow is also of considerable advantage in ear work, by giving us a more correct idea of any irregularities or variations in the curvature.

The fourth objection mentioned was the constant presence of the bright image of the incandescent filament, whether the light was used alone or in connection with a Mackenzie or a Tobold; whether beside a rhinoscopic or laryngeal mirror was employed. This fact has struck me as a peculiar advantage; it can be utilized, and will, I think, do us good service. As before mentioned, the bright image is surrounded by a less intense, but more general illumination. In this general illumination the lines of the image stand forth sharp and clear. This bright line enables us not only to study special structures, such as the macula lutea, the porus opticus, and the blood-vessels of the eye more thoroughly; but also if the image of the light be for part of its extent a straight line, it enables us to appreciate and estimate the degree of curvature of surfaces. Any elevation or depression present within the eyeball deflects the line of light; in posterior staphyloma there is a marked change in the direction of this line; the depth of the porus opticus is revealed by the angular deviation of the line; a slight elevation of the nerve is easily discovered by the same means. By means of this line, the degree of retraction of the membrana tympani and its curvature can be studied; in rhinoscopic examinations, the line is valuable for the same reason. In laryngeal examinations I have not found it of any service.

The unreliability of the light is, I think, at present a valid objection. It is, however, not the lamp which is at fault, but the batteries. All chemical batteries are troublesome to have about, many of them give off acid fumes, and besides require considerable attention, running down rapidly; but by the employment of double fluid batteries, which are fairly constant, the light can be made to be much more reliable.

At present, electric lights are expensive, not because of the original cost of the lamp itself, but because chemical batteries are expensive. There is, however, some hope of relief. At the present time, our electric light companies are keeping up steam all day for the running of their dynamo-electric machines at night; the cost is but little less than it would be were they to run them all day. There is no reason why the current should not be produced during the day, and be stored up to be employed as necessary. There would be thus be a direct saving effected. Physicians could be supplied in this way at a moderate expense, and would then have a reliable current.

Considering, now, the advantages of the electric light, we have, first and foremost, its approach to daylight—its whiteness. In all other artificial lights, with the exception of the calcium light, the yellow rays preponderate. Yellow rays are a decided disadvantage. So apparent was this to Wm. R. Wilde* that in his treatise on ear disease he writes, "Shades of vascularity produced by inflammation or congestion, speckled opacities, minute points of morbid deposit, and slight ulcerated abrasions, want of polish, and loss of transparency, etc, cannot be detected" by the artificial light. In the white light of the incandescent filament there are no yellow rays, and the illumination resembles very strongly a good day-light. Of course, if the current traversing the filament be not of sufficient intensity, we may have yellow light. A second advantage is its brilliancy or intensity. This brilliancy is so intense as to allow us the more readily to recognize slight changes; this is marked in ear examinations. By means of this light the rhinoscopic image becomes very much more distinct, and the membrana tympani shows slight changes not otherwise discernable.

There are two advantages possessed by this light which are often considered objectionable. I refer to the fact of the light casting strong shadows, and the presence of the image of the filament in the part illuminated. Having above set forth why I consider them as aids in examination, it is not necessary to say more.

The vitiation of the air by gas is a material objection, which is particularly noticeable in the dark-rooms of our eye dispensaries. The electric light would render the dark-room more bearable, and the headaches, so frequently occasioned, would be much less common.

For the larynx and posterior nares, Dr. Starr's or Dr. Seiler's laryngoscope, or Trouve's photophore, or the lights placed in a Mackenzie or Tobold condenser, can be employed.

The illumination of the ear is best attained by means of a small lamp placed close to the speculum, the lamp enclosed in a shield or cap, with a small round opening; if a large lamp be at hand,

* Diseases of the Ear, 1853, p. 69.

the employment of the head mirror to reflect the direct rays into the ear is not to be despised.

For the eye, the direct rays obtained from a large Edison or Swan lamp reflected into the eye prove of great service. These large lights are not always obtainable, and then the electric ophthalmoscope, before described, will be found to be of use.

In purchasing a light, those ranging from ½ to 3 c.p. of not more than 10 volts, should be selected from. Lamps of larger size cannot at present be employed without the use of a very large and expensive battery. Filaments of the Bodein, Baudet, Edison, and Swan patterns should be employed.

To run lamps of the size indicated, requires from 2 to 16 half-pint Grenet cells, or 4 half-gallon Fuller cells. If the battery is to be employed for the light alone, the Fuller cells should be bought.

For general use, a Baudet 9 volt lamp run by 4 half-gallon Fuller cells, is, perhaps, the most satisfactory that can be purchased at present.

When we all can have storage batteries charged by our electric light companies, we will be able to employ lamps of greater length of filament and of greater resistance, and will then become the more conscious of the advantages of the electric light over all the other lights for medical examinations; and they will then be as common as the Argand burner is to day.

I can do no less than acknowledge my indebtedness to Dr. Wm. H. Burk, for assistance kindly rendered during the course of this paper.

ADDENDA.

Simanovoski (Ejened Klin. Gaz. St. Peter's, vol. iii, 1883, p. 473,) describes the Trouvé electrical photophore, mentioning however that he had not even seen it.

De Wecker (De l'emploi de la luminère electrique en chirugie oculaire, Rev. Clin. d'Ocul., Oct. 1883) has employed the photophore electrique in the operation for cataract.

Messrs. Queen & Co., expect to be able to furnish the electrical ophthalmoscope described, in the course of a few weeks, by which time it probably can be obtained from opticians generally.